Fall 2018

The Future is Now Science Club

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NEBRASKA HONORS PROGRAM
CLC EXPANDED LEARNING OPPORTUNITY CLUBS
INFORMATION SHEET

Name of Club: The Future is Now Science Club

Age/Grade Level: 6th – 8th

Number of Attendees: (ideal number) 15-20

Goal of the Club: (learning objectives/outcomes)

Through *the weekly exploration of topics* from entertainment and urban life to space and artificial intelligence, students will gain the basic scientific understanding of these futuristic technologies, *many of which they may see or have the opportunity to work on in their lifetimes.*

Students will not only learn the basic scientific concepts behind each future technology, they will be challenged to *step into an engineer's shoes* and to engage with a present problem in order to come up with an effective solution. Subsequently, students will be asked to foresee problems with the future technologies introduced and discuss them amongst their peers.

For a schedule of weekly topics, see Appendix A.

Resources: (Information for club provided by)

Presentation Slides which include the key concepts and discussion questions
Activity and Supply Links (provided in subsequent lesson plans when needed)

Content Areas: (check all that apply)

☐ Arts (Visual, Music, Theater &Performance)

☐ Literacy

☒ STEM (Science, Technology, Engineering &Math)

☐ Social Studies

☐ Wellness (Physical Education, Health, Nutrition &Character Education)

Outputs or final products: (Does the club have a final product/project to showcase to community?)

Students will be inspired to think larger about the present world in which they live and about where it is going. Further, students will develop better teamwork, critical thinking, and problem-solving skills. The goal of this club is to give students a different approach to their math and science classes and to inspire them to pursue the exciting STEM fields.

Introducing your Club/Activities:

The days ahead are exciting! We are on the brink of solving some of humanities largest problems in mere decades. Through this club, students will explore the greatest, and the coolest, technologies being conceptualized today, learn more about what problems we currently face, be challenged to think critically, and be pushed to envision and to build their

solutions. Though, mostly importantly, *students will discover not only what is coming in the future for them, but they will be the inspired to go out and create it.*

General Directions:

Each Session begins with an "engage" part where the instructor will ask discussion questions that foreshadow the lesson. A brief group discussion about these questions will engage the students and give them a sense of the topic they will be exploring.

Next, to conceptually explore each week's topic, each topic is broken down into a set of key concepts. These key concepts contain the content of the club and give the instructor, as well as the students, guidance on what should be taken away from each lesson. The key concepts for each session. The instructor can best present these in an interactive content coverage fashion, frequently asking students to give their thoughts as the content is being presented.

The discussion questions, key concepts, and content for each session may be found in Appendix B.

Following the content portion of the session, students will engage in an interactive activity. These will vary in hands-on interaction and difficulty. Students will work individually, in small groups, and as a whole to complete these. All of the activities will help reinforce the key concepts learned as well as work to develop teamwork and critical thinking skills.

A bibliography is included in Appendix C.

Tips/Tricks:

The instructor is encouraged to research each topic before each session in order to answer students' questions and give intriguing information beyond the content. Further, some of the activities are challenging, and are meant to be so. The instructor should prepare to help students stay objective through the challenging interactive activities and to convey to students what the purpose behind each activity is.

For many of the interactive activities, the students might want to keep their creations, make sure to advise the students to be responsible with these during the school day.

Lesson Activity Name:	Session 1: Vision, Innovation, and the Engineer's Mindset Interactive Activity: What's Your Idea?
Length of Activity:	10-15 minutes
Supplies:	1. Computer Paper (1-2 per student) 2. Pencils and Colored Pencils

Directions:

Students will work individually to draw and illustrate a picture or plan for a futuristic idea they have. Students will be required to write one sentence about the purpose behind their idea and the problem(s) it will solve. During this work time, the instructor will individually prompt the students to think of potential challenges and barriers to their ideas and then prompt each student to think about how they may overcome these. Following the individual work time, students will share their ideas along with their purpose and problem in their small groups.

Conclusion of the activity:

The goal of this activity is to reinforce the key concepts of innovation and engineering previously covered in the session. From this, students will learn how to critically think about their invention/idea. Further, students will engage with their peers to explain the idea, the problem the are solving, and the potential challenges.

Lesson Activity Name:	Session 2: Healthcare Interactive Activity: Surgical Challenge
Length of Activity:	15-20 minutes
Supplies:	1. (1) 18”x18” carboard box 2. Cotton Balls to coat interior of box 3. (1) balloon (fill with a little sand or pea gravel 4. Package of straws 5. Two plastic forks 6. Two plastic spoons 7. Rubber bands 8. Masking tape 9. Detachable webcam connected to computer

Directions:

Students will work with a partner to construct their own surgical instrument with the goal of removing the balloon (organ) from the box (patient). See instructor set up for more instructions. Students will then have 2 minutes to attempt to remove the balloon from the box through the small incision holes. Each pair can use more than one instrument but only one may be used at a time. It is recommended that one student control the camera and watch the display while the other controls the instruments. The students may not move or tip the box during the activity.

Instructor Set Up: **(Prior to Session)** Line the bottom of the box with cotton balls. Lightly tape the balloon to the cotton balls in a corner of the box. Cut two slits in the top of the closed box just big enough to fit the fork or spoon through. Cut a final hole in the center of the top of the box just big enough for the webcam to view what is in the box. Note, if the webcam doesn’t have a light, cut a small hole for a phone light.

Conclusion of the activity:

This activity is designed to help students build teamwork skills. This activity can be frustrating for some students. The key is to encourage the students to stay calm and objective to have success. The goal of the activity is not only to illustrate the non-invasive surgical techniques but also the challenges surgeons face when conducting them.

Lesson Activity Name:	Session 3: Architecture and Urban Life Interactive Activity: Mile High Towers
Length of Activity:	15 minutes
Supplies:	1. 100 regular size popsicle sticks per group 2. (1) role masking tape per group. 3. (1) meter stick

Directions:

Students will work in groups to in a building challenge that will require them to think critically and develop teamwork skills. They will have 10 minutes to build the tallest tower they can out of the materials given (popsicle sticks). The goal is to make a tower at least 1 meter high but the instructor may give praise or a reward to the highest tower. Each tower must be free standing under its own weight.

Instructor Set Up: **(Prior to Session)** Draw an 8x8x8 inch equilateral triangle on a piece of letter paper (cardstock preferred). Tape this piece of paper to the floor for students to construct from.

Conclusion of the activity:

To simulate the challenge engineers face in building towers of this mile-high scale, the students must keep their tower base in the constraints of the 8x8x8 inch triangle (see instructor set up). Further, the instructor may give structural advice to the student groups as they work. Teamwork is vital for success in this challenge as is something the instructor should emphasize.

Lesson Activity Name:	Session 4: Food Interactive Activity 1: Taste This!
Length of Activity:	10 minutes
Supplies:	1. (1) Container of apple juice 2. Assorted food coloring 3. Small Dixie cups 4. Napkins 5. Quartered pieces of paper

Directions:

The instructor will prepare three apple juice samples for each student adding a different color of food coloring to each (red, blue, and green). The instructor may choose an individual student to help with this who can keep the "secret" (that all of the samples are apple juice). Following, the instructor will give each student the three samples and have each write what flavor they think each one is one a piece of paper. After, the instructor will reveal the "secret" and explain why the students fell for the trick.

Conclusion of the activity:

The goal of this activity is to illustrate how we actually taste our food. Taste is much more dependent on smell and sight than one might think. The instructor should discuss how food manufacturers color and scent food to sometimes "fool" customers to taste a desired flavor (an example is fruit loops). Further, the instructor should discuss how food manufacturers will use this more in the future as we continue to artificially make more and more of our food.

Lesson Activity Name:	Session 4: Food Interactive Activity 2: Moon Cookies (optional)
Length of Activity:	15 minutes
Supplies:	1. ½ cup wheat germ 2. 1 ½ cup peanut butter (use sunflower seed butter if food allergy) 3. 1 ½ cups honey 4. 3 cups dried milk 5. ¾ cup gram cracker crumbs 6. Powdered sugar for coating 7. Large Mixing bowl 8. Cookie sheet

Directions:

Student will work as a class to make the cookies. It is recommended that the instructor manage each step while choosing individual students to help with each one. Following, the students will have a "tasty" treat. The cookies might be a little "weird" tasting to some students, which is the point. Taste is often sacrificed for longevity in space.

Instructor Set up: **(Prior to Session)** Pre-split the ingredients into their correct amounts prior to the activity to save time if needed. Also, this can save you from having a large mess. Make sure to ask prior about food allergies and eliminate/replace any ingredient that may cause a reaction for a student.

Conclusion of the activity:

Following making the cookies, the instructor should host a group discussion while the students eat. The goal is to see what the students think of the cookies and to point out the challenges with perishable foods even down here on Earth at local grocery store.

Lesson Activity Name:	Session 5: Transportation Interactive Activity: Hovercraft Racers
Length of Activity:	10-15 minutes
Supplies:	1. (3) CDs 2. (3) plastic bottle caps 3. (3) balloons (may want more if one pops) 4. Super glue 5. Masking tape

Directions:

Students will work in 3 teams to each construct one of the three hover crafts. The instructor should provide guidance to each team on how to construct the hoover crafts so that each may be near the same as the others. First, students will super glue the caps to the CD so that the open end of the cap faces up and each hole in within the center hole of the CD. Next, the balloon needs to be inflated and pulled over the open end of the bottle cap without letting air escape. Students will need help with this step.

After, each student will make a hypothesis regarding which craft they think will work best. Following, each craft will be tested. Make sure students note which craft traveled the most distance, got the highest off of the ground, and was the most stable.

Instructor Set Up: **(Prior to Session)** Save three bottle caps and recycle the rest of the bottle. Drill 1, 2, and 3 holes in each bottle cap respectively. Size of drill bit should be the same for each hole.

Conclusion of the activity:

The goal of this activity is to work the students through the scientific process by formulating a hypothesis and then critically thinking about the results. Following the tests, the instructor should discuss with the class which craft worked best from an engineer's perspective. The students should consider things like safety (stability) and speed of each craft.

Lesson Activity Name:	Session 6: Technology Interactive Activity: 3D Holographs
Length of Activity:	15 minutes
Supplies:	1. 12" x 12" Acrylic Sheet (1 per group) https://www.amazon.com/dp/B006QZ7IVC/ref=biss_dp_t_asn 2. Rulers (1 per group) 3. Protractors (1 per group) 4. Scissors 5. Heavy Cardstock Paper 6. Sharpie Marker 7. Clear Scotch Tape 8. Cutting Blade/Knife

Directions:

Students will work in small teams to construct a 3D photo frame for this activity. Students should first use cut out the template into its 4 pieces and trace onto a sheet of acrylic paper using a sharpie. *After, the team should bring their sheet to the instructor to cut out each piece with the cutting blade/knife.* Following, the students should use a small piece of clear scotch tape to fasten the pieces together in an upside-down pyramid shape. Following, the students will place their frame, smaller side down, onto the instructor's smart phone with the video playing and observe the holographic image. *Make sure the room is dark.*

Instructor Set Up: **(Prior to Session)** You may print the template (next page) on the cardstock prior. Check the scale of the template before printing (should be 100%). Make sure you have a smart phone to display the hologram video on.

Video Link: https://www.youtube.com/watch?v=Y60mfBvXCj8
Template Link: https://maker.pro/custom/projects/diy-hologram

Conclusion of the activity:

The goal of this activity is to build teamwork skills along with attention to detail. Students are encouraging to take their time. The higher quality of their frame will result in a clearer 3D image. The instructor should discuss how the 3D frame reassembled the component 2D images from the video.

Lesson Activity Name:	Session 7: Space Interactive Activity: BOTTLE ROCKETS!
Length of Activity:	20-30 minutes
Supplies:	1. (1) 2-liter bottle 2. Rubber stopper 3. (1) straw 4. Masking tape 5. Water 6. Pressure Device 7. Wire and piece of wood for launch stand *Per Group Basis

Directions:

Safety is key with this activity. Students should work in teams to construct a bottle rocket with whatever fin shapes they think will work best. The students also need to tape a straw to the side of their bottle. They may also decorate their rockets. Following, the class will go outside (weather permitting) to test the rockets. Student should stand clear as the instructor sets off each rocket.

Instructor Set up: **(Prior to Session)** the instructor should make a stand with a wire (that fits in the straw) sticking upward to mount each rocket. The instructor also needs an air pressure device such as a balloon inflator or a bike bump.

https://www.sciencelearn.org.nz/resources/406-water-bottle-rockets

Conclusion of the activity:

Students will develop teamwork and critical thinking skills in this activity. During testing, students should observe how each rocket flies and how strait and stable the flight path is. Following testing all of the rockets, the class should discuss which one had the best and most stable flight and what about the rocket caused this.

Lesson Activity Name:	Session 8: Energy Interactive Activity: Solar Cars
Length of Activity:	15-20 minutes
Supplies:	**Materials Provided in the "Car-Kit":** • JSS-KIT and JSS-ACC • Solar panel • 2 axles • 4 wheels (sized to fit axle) • Driving gear (sized to fit axle) • Electric, DC powered motor • Different gears for motor **Materials Not in Kit!!!** • Balsa wood • Wood glue • Hot glue • Paints for customization (optional) Link to Kit: Junior Solar Sprint (JSS) Kit https://www.solarmade.com/store/product/jss-kit

Directions:

Directions Link:
https://www.teachengineering.org/content/duk_/activities/duk_solarcar_tech_act/solarcarhandout.pdf

Break students into teams according to class size and the number of JSS kits purchased. Instruct students to follow the procedure found in the directions link and assist students when needed. Following, allow the cars to charge in a window and then test to see the distance they travel. The instructor may want to begin the session with this activity and allow the cars to charge during the content portion of the session.

The instructor may also refer to the "things to consider" section in the directions link to further guide students through the construction of their cars.

Conclusion of the activity:

The goal of this activity is to illustrate the concept of solar energy and the challenges that engineers face when trying to capture it. Further, students will learn teamwork and carefulness as the quality of the students' cars will be a key factor in determining how far each will travel.

Appendix A: Schedule of Topics and Activities

Session 1: Vision, Innovation, and the Engineer's Mindset
Interactive Activity: What's Your Idea?

Session 2: Healthcare
Interactive Activity: Surgical Challenge

Session 3: Architecture and Urban Life
Interactive Activity: Mile High Towers

Session 4: Food
Interactive Activity: Taste This!
Interactive Activity 2 (optional): Moon Cookies

Session 5: Transportation
Interactive Activity: Hovercraft Racers

Session 6 Technology
Interactive Activity: 3D Holographs

Session 7: Space
Interactive Activity: Bottle Rockets!

Session 8: Energy
Interactive Activity: Solar Cars

Appendix B: Content Based Lesson Plans

Session 1: Vision, Innovation, and the Engineer's Mindset

Engage: (pre-content discussion questions)

1. What do you think of when you think of the Future?
2. What if I told you that most of your ideas are being conceptualized right now?
3. Would you believe me if I said the future is now?

Key Concept 1: Discoveries & Inventions

Students will discover the many future ideas that have changed the world in their lifetimes.

1. Top 10 discoveries in your lifetime (previous 10 years)
    a. Face Transplants
    b. Water as Fuel
    c. Creation of Artificial Organs
    d. Sequencing Genome of Cancer Patient
    e. Existence of Dark Matter
    f. Advancement of HIV Care
    g. T. Rex Tissue
    h. Robotic Prosthetics
    i. Evidence of Water on Mars
    j. Detection of Gravitational Waves
2. Top 7 inventions in your lifetime (previous 10 years)
    a. The Touch Screen
    b. Smart Phones (Mobile Operating System)
    c. Artificial Heart
    d. YouTube
    e. Social Media
    f. Global Positioning System (GPS)
    g. *Internet of Things….*
3. Club schedule of topics (logistical)
    a. Healthcare
    b. Architecture and Urban Life
    c. Food
    d. Transportation
    e. Technology
    f. Space
    g. Energy

Key Concept 2: Innovation

Students will be prompted to explore what it means to innovate. Following, the instructor's definition will be given and interpreted as a group.

Innovation = Vision…with a purpose!!

Key Concept 3: The Engineer's Mindset

Students will discover how engineers work to not only visualize ideas but also to use vision to develop sustainable solutions to global problems. This concept will be of emphasis throughout the club as additional futuristic concepts/ideas are introduced. Following, the 14 grand challenges of the 21st century will be introduced to show what problems engineers face in the near future.

Engineers look to overcome barriers to develop sustainable solutions to global problems. They stretch the limits of science, technology, and mathematics to make the once impossible possible.

14 Grand Challenges of 21st Century:

1. Make solar energy economical
2. Provide energy from fusion
3. Develop carbon sequestration methods
4. Manage the nitrogen cycle
5. Provide access to clean water
6. Restore and improve urban infrastructure
7. Advance health informatics
8. Engineer better medicines
9. Reverse-engineer the brain
10. Prevent nuclear terror
11. Secure cyberspace
12. Enhance virtual reality
13. Advance personalized learning
14. Engineer the tools of scientific discovery

Session 2: Healthcare

Engage: (pre-content discussion questions)

1. How long will we live in the future?
2. How will we treat injuries in the future?
3. Will we be defying our role as humans by reviving and extending life?

Key Concept 1: Health Informatics (10-15 years)

Right now, hospitals and medical providers are moving toward a completely computerized system. Your medical history from birth is most likely stored somewhere in a database.
When you head to the hospital for an appointment or even in an emergency, all of your records are instantly accessible to the doctors and nurses.

In the near future, health informatics will be part of your everyday life without you even knowing it. You house will have nutrition detectors and health screens to monitor your health habits subconsciously.

Also, in the future, while your clothes will look mostly the same as they do now, they will be far from it. They will be lined with millions of tiny computer chips that monitor everything from your body temperature to your heart rate. Thus, in the event you become unconscious, your clothing will identify the diagnosis, alert the EMTs of your location, and retrieve your entire medical history instantaneously.

How might this work?

Key Concept 2: Getting to the Hospital (50 years)

In the event of an emergency, in the future, your clothes will inform your healthcare provider of the nature of your injuries. After, the nearest hospital will be on alert for your arrival and a high-speed ambulance of the future will be dispatched.
The ambulance of the future will solve road congestion altogether by simply going above. In fact, NASA envisions a vehicle transport system in the sky in the near future and is developing a private air traffic management system right now.

Still, even with good management, in the future, millions of drivers in the sky may remain impractical. But this will be a perfect opportunity to streamline emergency services. *In 50 years, flying EMS will save time…and lives.*

Reversible Death:

In the event of a critical injury involving loss of blood or cardiac arrest, every second counts. In fact, EMTs have mere minutes to stabilize the body for the victim to have any chance at survival.
In the future, EMTs, in this case, will use a treatment call *reversible death (suspended animation).*

For this technique, the blood in the body is replaced with a saline solution to cool the body to 50°F which, in turn, will cease all heart and brain function.
Way to stop the clock!

Key Concept 3: Future Procedures

Nano-sensors:

In the future, microchips will become nanochips. These nanochips may by inserted into your body and communicate with a microchip in your brain. A series of nanochips can be inserted into your body to create an intelligent computer network that operates simultaneously as you do.
With this technology, bones can heal faster, injuries can better repair themselves, and paralysis may become a condition only known in the history books.

Artificial Organs:

Right now, millions of dollars and some of the best medical minds are working to advance the man-made parts we can substitute for body parts in the event of injury.
These include things such as prosthetic limbs, bionic hands, and artificial hearts.

Though, given the extremely strenuous and cyclic requirements of your organs, artificially made organs come with limits. For instance, a typical heart valve will pump nearly 70 million gallons of blood in its lifetime. Even with the best artificial materials, this is a challenge to any engineer.

Tissue Engineering:

What if…just like a car, you can go to the hospital to get replacement parts for your body? What if we could replace artificial organs with real biological ones? In fact, with advances in tissue engineering, this phenomenon may become a reality within your lifetimes.

Casting Heart Values from Grown Cells (Helmholtz Institute for Biomedical Technology)

- A mold is crafted in the shape of a heart valve.
- A solution of heart cells and proteins are inserted to "cast" the valve
- A solution that then adheres the cells and proteins is added (acts like a glue)
- New heart valve is put into a simulated heart environment for the cells to mature

3D Printed Organs and Tissues: *Bio-Printing Laboratory at the University of Clemson (Dr. Thomas Boland)*

Experiment One:

- A standard inkjet printer was slightly modified to print bacterial cells on a bio-gel paper.
- Not only did the cells print in the pattern given, the cells survived the printing.

Experiment Two:

- Dr. Boland modified the printer again to try and print multiple layers of heart cells.
- Following, an electrical impulse was applied, and the cells started to beat!!!

[Clemson University Logo Printed Using Organic Cell Matter] (2015).
Retrieved From: https://cecas.clemson.edu/biofab/RodriguezResearch.html

Group-Discussion: Advanced Procedures with a Price (is access to the best of healthcare a privilege or a right?).

Session 3: Architecture and Urban Life

Engage: (pre-content discussion questions)

1. What do you think the population will be in 2050?
2. Where will the majority of these people live in the future?
3. As land becomes scarcer, where can we build to accommodate all of these people?
4. What do you think of when you think about future cities?

Key Concept 1: The Home of the Future

The home of the future will be integrated with the internet to control your every convenience. Whether its setting the temperature how you like, automatically turning on the lights and your favorite shows when you arrive, letting you know who is ate the door when you are away, or even ordering groceries as you use them, the home of the future will work to satisfy your every need.

Every home will have its very own central computer. It will integrate endless streams of data to make the home truly a living organism. When you walk into a room, it will become alive.
The computer will use this data to control everything from your lights, appliances, electronics, and even the house itself instantaneously with your command. Soon, you may be logging into your home just like you'd log into a modern-day computer.

Key Concept 2: Nature in the City

Bio-architecture will continue to merge cities with the natural elements that they themselves have replaced. Cities will become increasingly green and eventually become self-sustainable.
Further, buildings of the future will be designed with nature in mind. Parks and artificial forests will float in the heights of skyscrapers. Nature will take over city architecture as we know it.

In fact, many modern-day examples of bio-architecture exist in our cities.
Pioneering in this field was architect Frank-Lloyd Wright (1867-1959) who's broadacre city proposal truly proposed a city that was integrated with nature.
From this, it is clear that the city of the future will be one with nature itself.

Key Concept 3: Network City

While cities will become more with nature in the future, the true revolution is in what you won't see.
In the future, city services such as fire, EMS, police, and hospitals, as well as critical infrastructures like roads, airports, trains, and water distribution will all be linked. Billions of computer chips will integrate the city of the future like cells of a complex organism.

The whole city can be controlled by a giant super computer, or brain, of the metro. This will allow city officials to effectively respond to emergencies and save lives. Trains can be stopped, autonomous cars diverted, all in an efficient response.
In the future, this type of central city network will run cities and their residents will use it every second of every day

But, no matter how advanced computer technology becomes, cyberspace will never be 100% secure. With a massive network controlling every aspect of a future city, a virus can cripple a city, an entire electrical grid, and even crash an economy.
For this reason, preventing cyberterrorism will be a national priority in the future.

Key Concept 4: Building Underground

Although enormously tall buildings now dominate many urban landscapes, in the future building underground will be just as common as building skyscrapers is today.
In fact, many cities today have recognized the value of building below grade. For instance, Boston rerouted many of its busiest highways underground in the "Boston Big Dig". Following completion of this project, downtown Boston was then filled with parks and green space where the massive highways used to lay.

The year is 2057, and you have boarded an elevator off of the streets of Downtown Chicago. Except, you are heading down ward 50 stories below ground to the city center equipped with all the services and amenities of a modern city.
This idea has already been conceptualized and is even looking for investment. The plan is to build a city stretching from the surface to 1200 feet below ground. Though, many safety and physiological barriers remain to be overcome.

Key Concept 5: Building Up, Up, and Up…

How high can we build?

Currently, the world's tallest tower, the Burj Khalifa in Dubai, is 2,717ft (828m) in height. Even this dizzying tower is about to be surpassed by the Kingdom Tower in Saudi Arabia at 1km (1000m) high. It is clear, in the future, skyscrapers of a mile high or more will take us into the sky like never before.
In fact, the first person ever to design a mile-high was Frank Lloyd Wright in 1957 for, once again, Chicago.

Today, a daring design for such a tower exists for Tokyo Japan. This project is expected to be completed by the year 2045.
These future "sky cities" will allow one to live their entire life without ever having the need to place their feet upon the Earth.

[Rendering of Tokyo's Mile High Tower Planned for 2045] (2016).
Retrieved From: https://www.telegraph.co.uk/travel/news/Tokyos-mile-high-skyscraper-to-be-the-tallest-in-the-world/

Session 4: Food

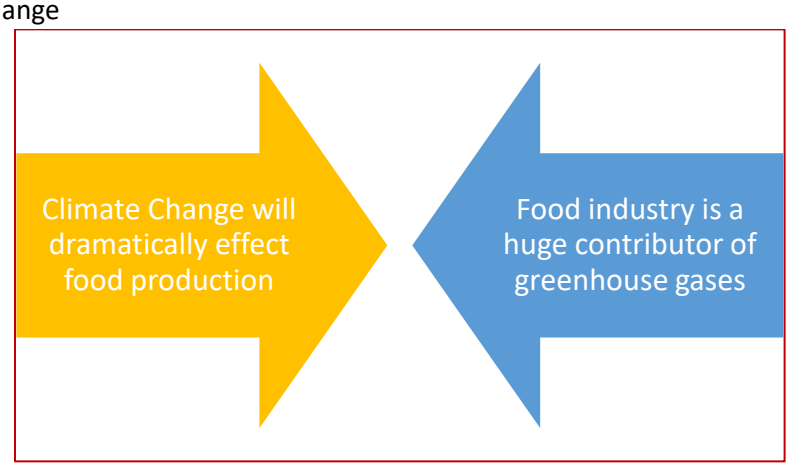
Engage: (pre-content discussion questions)

1. How do you taste what you eat or drink?
2. How much food do you think we waste on a given day?
3. What challenges are there to growing and producing food?

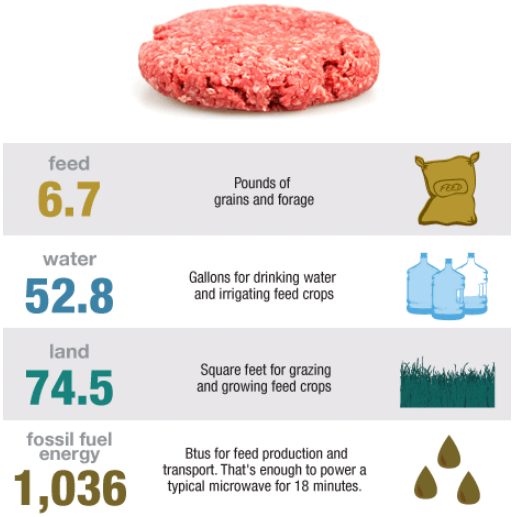
Key Concept 1: Challenges to Food Production and Distribution

During this part of the session, the students will learn and discuss the challenges behind the current food industry. For this, the students will learn where their food comes and the difficult logistics behind their favorite meals.

1. Growing Population (9.8 billion by 2050)
2. Climate Change



3. Water Demand (over 70% of fresh water is used for agriculture)
    a. Many countries are running out of fresh water from lakes and aquifers (i.e. California)
4. Continuing Industrialization increases the demand for meat.



Source: J.L. Capper, Journal of Animal Science, December 2011.
Credit: Producers: Eliza Barclay, Jessica Stoller-Conrad; Designer: Kevin Uhrmacher/NPR

5. Pollution of the world's oceans threatens the commercial fishing industry

Key Concept 2: Future Technologies in the Food Industry

Presented in a problem and solution format.

Synthetic Biology:

Synthetic Biology will work to create new plants and animals by modifying DNA strands and coding to obtain desirable characteristics. Mainly, creating food sources that produce more yield while consuming less resources.

In fact, in 2015, the Food and Drug Administration (FDA) approved a synthetically developed salmon for dinner. This salmon was created using a growth hormone from Chinook salmon and genes from an ocean eel species.

This salmon grew to market size twice as fast as others while consuming less resources than any other animal or fish mass produced in the food industry.

Genetically Modified Organisms (GMOs):

Video Link: https://www.youtube.com/watch?v=XgOZCHFk30I

Synthetic Meat:

Yes, it is exactly how it sounds. Meats such as beef, poultry, and seafood are currently being engineered in the laboratory to taste, feel, and have the nutritional value of natural meat.

Will this meat meet consumer expectations?

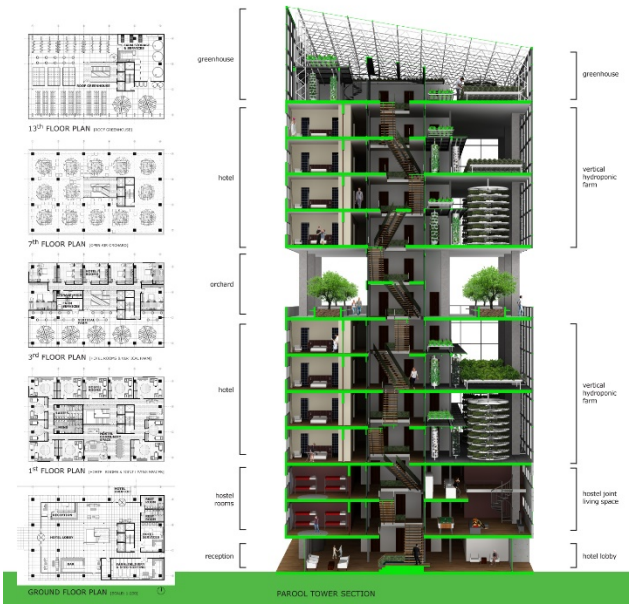
Is this natural?

This are questions for you to answer in the future….

Or we could just all cultivate insects for protein which is expected to increase in coming decades.

Vertical/Urban Farming:

Bio-architecture will lead the way for urban agriculture. Hydroponics will lead the way for growing food vertically.



[Urban Farm Design by KONO] (2010).

Retrieved From: http://pichintergrundbildererx.pw/KONO-DESIGNS-UrbanFarm-Urban-Farming-t.html

Autonomous agriculture:
Self-driving combines and tractors
Microsensors to monitor plant health and minimize water use
Artificial Intelligence to help us better understand the genetic workings behind our foods.

Key Concept 3: Future Trends in the Food Industry; what will the food industry look like in….20, 30, or even 40 years?

Students will learn some predictions of the food industry in the near future. Students will gain a taste of what they might be eating in the future…which isn't what they might expect. Many of the needed solutions to the challenges of today's food industry involve reversing some of the food trends we see today.

How or what will we eat in the future?

Many of the current trends we are seeing today in the food industry might reverse course in the future. Today, many of our favorite foods are made from artificial chemicals/substances, aren't very healthy for our bodies, and are shipped long distances to our dinner tables.

Though, in the future, we may expect all three of these trends travel in the opposite direction.

Future Trend 1:
With the integration of our food into our local economies and the presence of vertical farms, we may expect to see our food become more localized. This will lead to less chemical preservatives in our foods which, in turn, means they will be healthier for us.

Future Trend 2:
With the development of synthetic biology and the continued use of GMOs, we may expect to eat much more produce…and less natural meat. This will prove to be more efficient because, as seen with the quarter pound hamburger, producing meat is very resource demanding.
But, to my meat lovers out there, don't worry. There will be plenty of synthetic meat out there for you to snack on.

Future Trend 3:
Autonomous automation of the food industry, microsensors, and even A.I., will enable us to better understand how our plants grow and, thus, to nurture them better. Further, improved distribution of our food will get better, natural, and locally sourced food to our tables faster.

Future Trend 4:
Who doesn't love some good junk food? What are some of your favorites?
While this food tastes good, it is bad for you. In fact, much of it is not even food when thought about in the traditional sense.
Though, in the past decades, the presence of junk food in our diets has exploded. Because of the setup of the current food industry, producing junk food is simply cheaper. Though this has led to a health epidemic in many of the worlds developed nations.

IN THE FUTURE, THE LOCALIZATION OF THE FOOD INDUSTRY WILL REVERSE THIS TREND…DRAMATICALLY.

IT WILL BECOME CHEAPER TO PRODUCE AND BUY NATURAL (HEALTHIER) FOODS LOCALLY THAN IT IS TO BUY JUNK FOOD TODAY.

WITH THIS, NUTRITION AND DIETETICS IS EXPECTED TO EXPLODE IN THE FUTURE.

THIS IS BECAUSE INCREASINGLY MORE PEOPLE WILL BE WILLING TO PAY FOR GUIDANCE ON THEIR DIETS.

THOUGH, BEFORE YOU PANIC, JUNK FOOD WILL STILL VERY PRESENT IN THE FUTURE.

THOUGH, IT WILL BE SIGNIFICANTLY MORE EXPENSIVE.

Session 5: Transportation

Engage: (pre-content discussion questions)

1. What are the challenges with the current ways in which we get from A to B?
2. Is autonomous transportation truly safe?
3. What do you think is the most important design aspect of future transportation methods?

Key Concept 1: Personal Transportation (2025)

Tired of walking everywhere? Me too. In the future, walking won't just be an inconvenience but simply inefficient.
That is why, a huge market is emerging for personal transportation devices. Even today, we see examples of these in Segway's and Hoverboards.

Introducing the WalkCar, from Cocoa Motors. In fact, this car is smaller and lighter than many of today's laptops. Moreover, this car is retailing now and gaining ground in large urban areas such as Tokyo.

[Cocoa Motor WalkCar] (2018).
Retrieved From: https://www.cocoamotors.com/

In coming years, much more complex and sophisticated personal transport devices will come to the market. All making it easier for people like you and I to move around speedily.
In the meantime, it'd be best to work on your balance.

Key Concept 2: Autonomous Vehicles (2035)

A main part of this concept is that autonomous vehicles are safer and more predictable than human drivers. This is a good point to stop and debate.

Many of the major motor companies of the world are already developing completely autonomous vehicles. With this, tech companies like Apple and Google are racing to take their share in this market. Though complete automation is not yet realized many cars today have advanced autonomous features. Modern cars on the road today can park themselves and even keep their drivers from drifting out of their lane. Not to long from now, we can expect to see completely driverless cars at the local car dealership.

The Google Car

1) Sensors to interact with the world surrounding the vehicle
2) A rooftop LIDAR camera that uses multiple laser arrays to measure distances between objects in every direction. This builds a 3D map of the area up to 200 meters.
3) A windshield camera that works to detect unexpected hazards like pedestrians and cyclists. This camera also works to read road signs and traffic lights.
4) Rear Mounted GPS to locate the car's exact position
5) Intelligent cruise control to track the cars in front and behind itself
6) Internally, the car has an altimeter, gyroscope, and a rev-counter all working together to identify the car's position and conditions.

Which is safer, autonomous vehicles or those with human drivers??

Your Brain	**Autonomous Vehicles**
Can adapt to changing conditions well like sunlight and weather.	Camera's can't replace adaptability of human eye
Prone to distractions	Very predictable
Ignores 80% of what it takes in.	Analyzes *all* of the information it takes in
Unpredictable in the actions it will take	Won't text and drive

The Human Problem

Before completely autonomous cars hit the roads, engineers need to solve the human problem. Simply, the biggest challenge to going driverless is the drivers that remain. A computer can communicate its exact response instantly to another computer and a predictable as well as safe response can be taken. Though, because of the unpredictability of your brain, an autonomous car cannot predict what a human driver will do as easily.

In fact, in July of 2018, the google car was involved in an accident. The cause, a human driver failing to stop at a red light.

Key Concept 3: Urban Mass Transit

Ever been stuck in traffic? If so, you are surely not alone. In fact, Texas A&M University estimates that city dwellers spend an average of 42 hours annually stuck in traffic. This not only costs you precious time, but it also costs the economy billions of dollars.

Clearly, cities need a solution to the car problem. One that avoids car jammed roads altogether.

Now, cities like New York have had an underground subway for years, but at a cost. That cost, $2 billion dollars per mile! In fact, New York's recently completed 2nd Avenue Subway came in at a hefty $2.5 billion per mile.

What is a potential solution to this problem?

If you said digging underground, you are sharing the vision of Elon Musk, CEO of Tesla, SpaceX, and a start-up venture called Boring, which stands for Tunnel Boring.
Why Tunnel?

- No practical limit to how many tunnels or layers of tunnels can be built
- Tunnels are weatherproof
- Tunnel construction occurs without citizens even noticing
- Tunnels will allow for more connected communities with a lesser need for physical roads and barriers

Though, Elon Musk with his Company, is looking to cut this price dramatically by a factor of 10 to make tunneling financially feasible.

1. Making the tunnels smaller in diameter
2. Increase Tunnel Boring Machine (TBM) power and continuous use
3. Automate the TBM and go electric
4. Beat the snail (snail is approximately 14 times faster than TBM)

If Elon Musk succeeds in his vision, in our future cities, the ground below your feet will be lined with tunnels. In fact, in the future, your car will be lowered from it's very parking spot into an underground tunnel and then transported by electric pod to your destination at mind-blowing speeds.

Still above ground, an invention entitled Land Airbus, uses the existing roads, but avoids the traffic. Similar to a monorail in today's cities, the Land Airbus simply glides above traffic with ease. So next time you see traffic congestion, you may be comfortably riding above the cars to your destination.

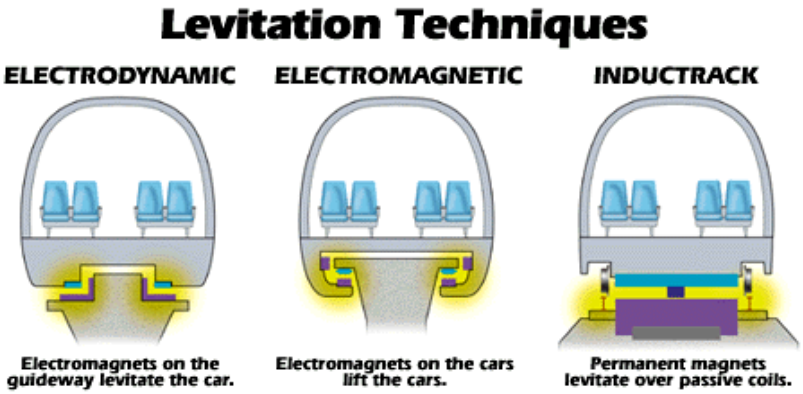
[Concept Design of the Land Airbus] (2016).
Retrieved From: https://performancedrive.com.au/innovative-land-airbus-help-traffic-china-video-2921/

<u>Key Concept 4:</u> Bullet Trains
Instructor will have to define friction.

Why can't today's trains truly travel the speed of a bullet? Well, friction, a major inhibitor to speed today, a minor inconvenience in the future.

This is because of an invention called Maglev, standing for magnetic levitation. Using electromagnets, on the bottom chassis of the train as well as on the track, entire trains can be made to float.
In Shanghai, the world's first maglev was opened in 2004. This train is the fastest in the world with a top speed of 268 mph.

<u>How does Maglev work?</u>
Maglev trains take advantage of the attractive and repulsive forces of magnets and magnetic fields. By passing an electrical signal through an electromagnet, trains can be levitated (repelled) from the track and guided (attracted) to the guideway. The electrical signal intensity can change the speed, direction, and elevation of the train from the track.



[Mechanical Schematics of Maglev Levitation Techniques] (2015).
Retrieved From: https://propelsteps.wordpress.com/2015/04/23/know-how-maglev-trains-works-without-wheels/

<u>The Hyperloop:</u>
So, we have solved friction, but what about air resistance? Again, a major challenge today, a minor inconvenience in the future.
The Hyperloop, a brain child of Elon Musk, simply takes a Maglev train and surrounds it with a loop. The trick is, the air is pulled out of this loop so that the train travels through a near vacuum. Problem Solved. In fact, Dubai hopes to have a short section of an operational hyperloop completed for the World-Expo in 2020.

It is clear, in the future, hyperloops will lift all of the limits on how fast passenger trains can travel.
The year is 2090, you have just boarded a train in New York City. Except this is not ordinary train, it is the transatlantic tunnel connecting New York to London through a hyperloop tunnel submerged in the Atlantic Ocean. Travel time: 54 minutes. Speed: 5000 miles per hour.

Key Concept 5: Flying individually and commercially

Tired of flying coach or waiting in line at the airport. Well, in the future, why go to the airport when you will have your very own flying car!

How may we ensure safety with individual flying cars?

At least that is the vision engineers at a Boston based company called Terrafugia hope to make happen. Their invention, the TF-X, will become the first fully autonomous flying car. This embodiment of style can go a top air speed of 200 mph and travel up to 500 miles.

Powered by a 300-horsepower internal combustion engine along with two 600-horsepower electric motors for propulsion, this flying vehicle is also quite efficient.
Also, it is equipped with multiple advanced safety features which will avoid bad weather, air traffic, restricted airspace, and even perform a full emergency landing if called upon.
So, gather three of your closest friends and take to the skies!

[TF-X by Terrafugia] (2018).
Retrieved From: https://uncrate.com/terrafugia-tf-x-flying-car/

Session 6 Technology

Engage: (pre-content discussion questions)

How fast will computers be in 20 years?
How will the internet affect our lives in the future?
Are there drawbacks to our dependence on technology and the internet?

Key Concept 1: Top 10 Future Trends in Technology (presented from 10 to 1)

1. Earth won't be the sole planet with Internet

   By 2030, Mars will become the second planet with internet access.
   CEO of SpaceX, Elon Musk, plans to develop a human colony on Mars by 2030. And, going with them, the internet.
   To achieve this, satellites will be sent to orbit Mars that will transmit internet content…just like they do for Earth today.
   Though, any message sent from Mars back to Earth will take 24 minutes to reach its recipient

2. The Internet will be global….and fast!!

   Tech giants, like Facebook's Mark Zuckerberg are setting a goal to expand the internet to the entire world. As of now, 55.1% of the world has internet access.
   With the continued use of satellites to convey internet messages, it is feasible to expect Zuckerberg and others to reach this goal in the coming decade.
   In fact, technology is in development right now to transfer massive amounts of information from the internet by laser. If successful, this means Terabytes of information could be transferred across the globe at the speed of light.
   From this, the average user could expect multiple Gigabyte per second speed in the near future.

3. The Internet of Things

   Already, the "internet of things" is connecting aspects of everyday life. In one house, the refrigerator, air conditioner, and TV can be connected by the internet.
   In 15 years, the internet of things will extend to every part of your life. Everything from cars to currency will be connected with the internet and run with your phone.

4. Privacy will be a commodity

   When you go on the Internet to Google something, who all can see your what you searched?
   With constant internet connection in the future, privacy will become even more of a concern than it is today. In fact, privacy online will become a commodity (something that you pay for).
   Even today, much of your internet data is actually stored and sold to advertisers.
   What are the benefits and drawbacks to constantly being "on the grid"??

5. Machines do the Work

   We all know that robots are becoming more complex in the tasks they can do. And, in the future, this trend will only accelerate.
   What are the benefits of this?
   From robots, we may expect manufactured goods to be of higher quality, be produced faster, and cost less.

6. Virtual Reality will be in Everyday Life

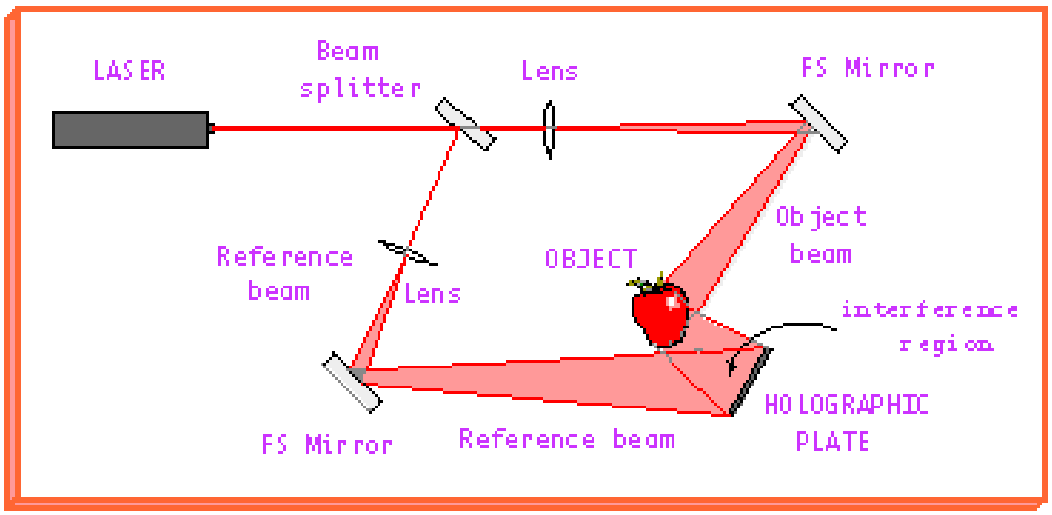
   Right now, virtual reality is still largely in development. But, in the future, virtual reality promises to take us places we've never been and to talk with people we've never meet.
   In the future, by simply putting on a set of VR glasses, you can step into a classroom across the world, or visit the Eifel tower, all from the comfort of your own home.

7. Internet Connection will be Automatic

   How often are you on the internet? Hint: it's probably more than you think.
   Right now, wherever you go, in order to connect to the internet, you probably have to connect to the Wi-Fi or maybe can use data on your phone for a price.
   In 10-15 years, these methods will be obsolete with the implementation of the universal internet.
   With this, wherever you go your devices will be constantly on the internet.

8. Holograms

   Yes, they are coming. But how do they work?
   Put simply, a hologram can be thought of as simply a light recording…. like a musical song being reproduced by electrical signals.
   Light is scattered off of a target object and the resulting light field is recorded. This way the light field can be reproduced by another set of lights or laser to produce the full 3D image.
   What is the difference between an image and a hologram?

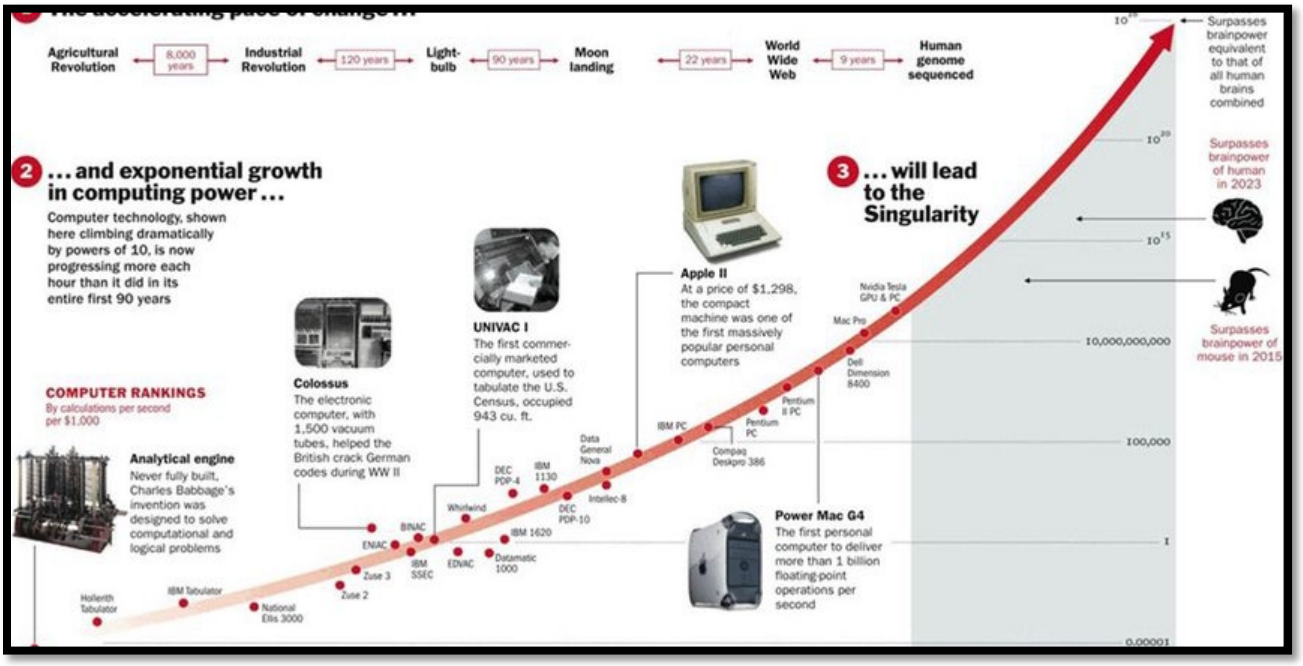


[Schematic Diagram of Hologram] (2007).
Retrieved From: https://van.physics.illinois.edu/qa/listing.php?id=1926

9. Nano-tech

   What is Nanotech?
   In the next 20 years, micro and Nano-sensors will be implanted in everything from the walls of our house, to our clothes, to even us. These sensors will be connected to the internet to submit data and be controlled by us.

10. Computing Power



[Growth of Computing Power] (2018).
Retrieved From: https://www.researchgate.net/figure/Exponential-growth-of-the-computing-power-Source-Time-Magazine_fig4_318502923

Session 7: Space

Engage: (pre-content discussion questions)

What different challenges are present in space that are absent on Earth?
What is the significance (importance) of space exploration?
How advanced will we as a species become in the future?

Key Concept 1: Getting to Space

Disadvantages of the Space Shuttle
Space Elevator by 2040

Key Concept 2: Exploring New Worlds

Mars and Europa are the most "Earth-Like" objects in our solar system
Proxima Centauri

- Closest Planet to Earth in Goldilocks' zone.
- 4.2 light years or 25 trillion miles from Earth.

Key Concept 3: Potential for Life

(argument adapted from a Washington University lecture given from Neil DeGrasse Tyson).

Most Common Elements of Life

1. Hydrogen
2. Carbon
3. Oxygen
4. Nitrogen
5. Other

Most Common Elements in the Universe

6. Hydrogen
7. *Helium (inert!!)*
8. Carbon
9. Oxygen
10. Nitrogen
11. Other

Key Concept 4: Human Colonization

The Martian (2015)
Elon Musk with SpaceX hopes to send the first crewed mission to Mars in 2024 and have a self-sustaining colony by 2040.

Key Concept 5: The Kardashev Scale

Type 0

A civilization that harnesses the energy of its home planet, but not to its full potential just yet.

Type 1

A civilization that is capable of harnessing the total energy of its home planet.

Type 2

An interstellar civilization, capable of harnessing the total energy output of a star.

Type 3

A galactic civilization, capable of inhabiting and harnessing the energy of an entire galaxy.

Type 4

A universal civilization, capable of harnessing the energy of the whole universe.

Type 5

A multiverse culture, capable of harnessing the energy of multiple universes.

Type 6

Even more abstract is the type VI civilization. The type VI exists *outside* of time and space, and is capable of creating universes and multiverses, and destroying them just as easily. It's similar in concept to a deity.

Session 8: Energy

Engage: (pre-content discussion questions)

1. Where do we get our energy from?
2. What is the problem with Fossil Fuels?
3. What is a renewable energy source? Do you know any examples?

Key Concept 1: Fossil Fuels and Climate Change

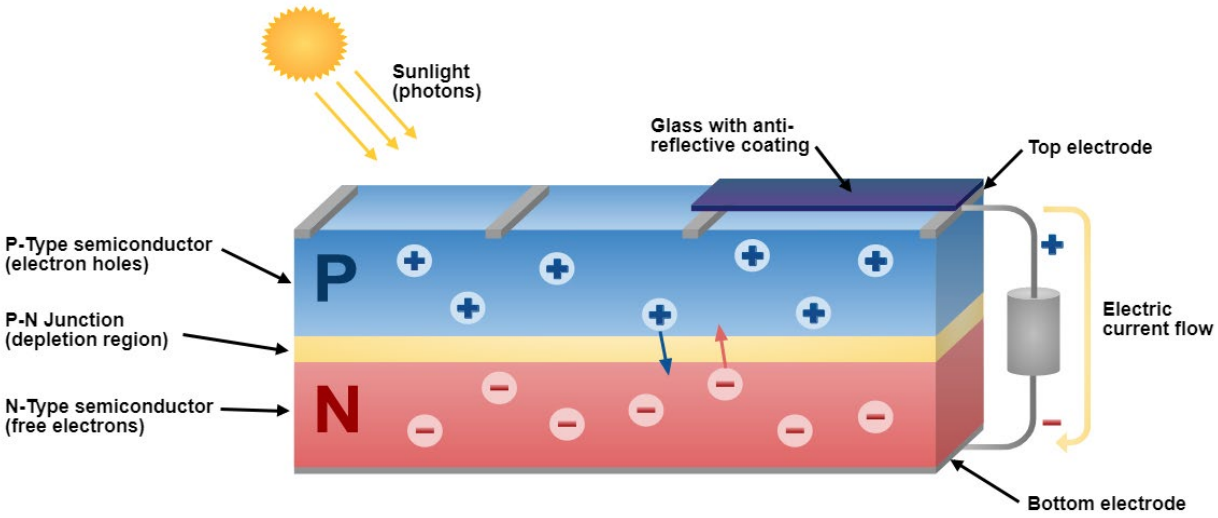
Greenhouse Gases (carbon dioxide)
Contributors to Climate Change/Emitters of Greenhouse Gases
Ozone
Negative Effects of Climate Change in the near Future

Key Concept 2: Renewable Energy Sources for the Future

Wind Turbines
Solar Energy
Ocean Wave Capture and Tidal Energy
Hydroelectric Dams (Hoover Dam and Three Gorges Dam)
Biofuel's

Key Concept 3: Solar Energy and Photovoltaic Cells

How does a photovoltaic Cell work?

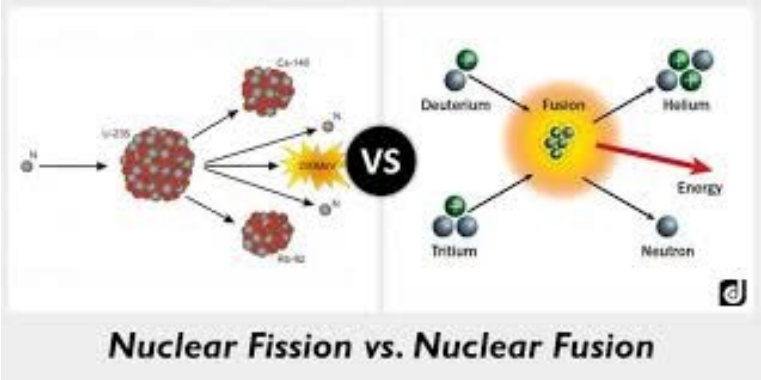


[Diagram of Photovoltaic Module] (2018).
Retrieved From: http://www.apricus.com/solar-pv-systems-pv-panels-19.html#.XA9CAmhKhPY

Today's most efficient solar cells only convert 18% of the sun's energy into useful electricity! In the near future, scientists want to increase this number to 60-80%.

Key Concept 4: Nuclear Fusion

Fission and Fusion – Unlimited Energy!



[Difference Between Fission and Fusion] (2015).
Retrieved From: https://www.differencebtw.com/difference-between-nuclear-fission-and-nuclear-fusion/

In 2017, the first fusion experiment to successfully create plasma occurred at the United Kingdom's ST-40 reactor. The plasma created inside the reactor was hotter that the surface of the sun. Imagine that energy!

Key Concept 5: Challenges to Renewable Energy

Capital Costs
Existing Infrastructure and Industries (Oil and Coal)
Culture
Energy Dependence

Appendix C: Bibliography

Session 1:

Barret, Oscar. "10 Greatest Scientific Discoveries and Inventions of 21st Century." *ISB Glasgow*, 22 Aug. 2018, www.isbglasgow.com/10-greatest-scientific-discoveries-and-inventions-of-21st-century/.

National Academy of Engineering. "Challenges for Engineering." *Grand Challenges - Engineer Better Medicines*, 2018, www.engineeringchallenges.org/challenges.aspx.

XpressPlanet. "7 Greatest Technological Inventions of 21st Century." *XpressPlanet*, 30 June 2017, www.xpressplanet.com/greatest-technological-inventions/.

Session 2:

George Washington University School of Business. "How We Can Expect the Healthcare Industry to Change in the Future." *Healthcare MBA GWU*, 20 Sept. 2017, healthcaremba.gwu.edu/blog/how-we-can-expect-the-healthcare-industry-to-change-in-the-future/.

"Our Body." *Update - Our World in 50 Years - Episode One*, 2015, www.youtube.com/watch?v=FjrG-Ab527s&t=1307s.

Session 3:

Chung, Stephy. "Dizzying Heights: Tokyo's Future Skyline Could Include a Mile-High Skyscraper." *CNN*, Cable News Network, 17 Nov. 2016, www.cnn.com/style/article/tokyo-mile-high-skyscraper/index.html.

"Our Cities." *Update - Our World in 50 Years - Episode Two*, 2015, www.youtube.com/watch?v=OYh53pV98Cc&t=1116s.

"Underground City." *Mega Engineering (S01E05)*, Discovery, 2014, www.youtube.com/watch?v=yVkyfC_AOLI.

Session 4:

Askew, Katy. "2018 And beyond: Five Mega-Trends Set to Shape the Food Industry." *Foodnavigator.com*, William Reed Business Media Ltd., 3 Jan. 2018, www.foodnavigator.com/Article/2018/01/03/2018-and-beyond-Five-mega-trends-set-to-shape-the-food-industry#.

McMahon, Daniel. "Feeding the Future: How the Food Industry Is Changing." *ThoughtWorks*, 6 July 2017, www.thoughtworks.com/insights/blog/feeding-future-how-food-industry-changing.

"Special Report: Future of the Food Industry." *Financial Times*, Financial Times, 7 Dec. 2017, www.ft.com/reports/future-food-industry.

Session 5:

The Boring Company. "FAQ Section." *The Boring Company*, 2018, www.boringcompany.com/.

Captain, Sean. "Humans Were to Blame in Google Self-Driving Car Crash, Police Say." *Fast Company*, Fast Company, 7 May 2018, www.fastcompany.com/40568609/humans-were-to-blame-in-google-self-driving-car-crash-police-say.

Cocoa Motors. "Promotional Video." *WALKCAR | COCOA MOTORS.inc.*, 2016, www.cocoamotors.com

Guizzo, Erico. "How Google's Self-Driving Car Works." *IEEE Spectrum: Technology, Engineering, and Science News*, IEEE Spectrum, 18 Oct. 2011, spectrum.ieee.org/automaton/robotics/artificial-intelligence/how-google-self-driving-car-works.

SpaceX. "Hyperloop." *Space Exploration Technologies Corp.*, 2017, www.spacex.com/hyperloop.

"The TF-2 | Seamlessly Travel by Air & Ground." *Terrafugia*, 2018, terrafugia.com/tf-2/#about-section.

Whyte, Chelsea. "How Maglev Works." *Department of Energy*, www.energy.gov/articles/how-maglev-works.

Session 6:

Singh, Sarwant. "Top 10 Tech Trends For 2018." Forbes.com, Forbes Magazine, 2 Feb. 2018, www.forbes.com/sites/sarwantsingh/2018/02/01/top-10-trends-for-2018/#70dc22637cb3.

Session 7:

DeGrasse Tyson, Neil, director. *Neil DeGrasse Tyson Lecture*. University of Washington, 2011, www.youtube.com/watch?v=wp6cnp1kZBY.

Ratner, Paul. "7 Types of Advanced Cosmic Civilizations." *Big Think*, Big Think, 10 Sept. 2016, bigthink.com/paul-ratner/this-mind-bending-scale-predicts-the-power-of-advanced-civilizations.

Williams, Matt. "Closest Planet Ever Discovered Outside Solar System Could Be Habitable with a Dayside Ocean." *Phys.org - News and Articles on Science and Technology*, Universe Today, 17 Sept. 2018, phys.org/news/2018-09-closest-planet-solar-habitable-dayside.html.

Session 8:

Intergovernmental Panel on Climate Change. "Rapid response needed to limit global warming: Summary for Policymakers of IPCC Special Report on Global Warming of 1.5°C approved by governments." ScienceDaily. ScienceDaily, 8 October 2018. <www.sciencedaily.com/releases/2018/10/181008075147.htm>.

Knier, GIl. "How Do Photovoltaics Work?" *NASA*, 2018, science.nasa.gov/science-news/science-at-nasa/2002/solarcells.

Metcalfe, Tom. "Nuclear Fusion Power Could Be Here by 2030, One Company Says." *LiveScience*, Purch, 28 June 2018, www.livescience.com/62929-plasma-fusion-reactor-tokamak.html.